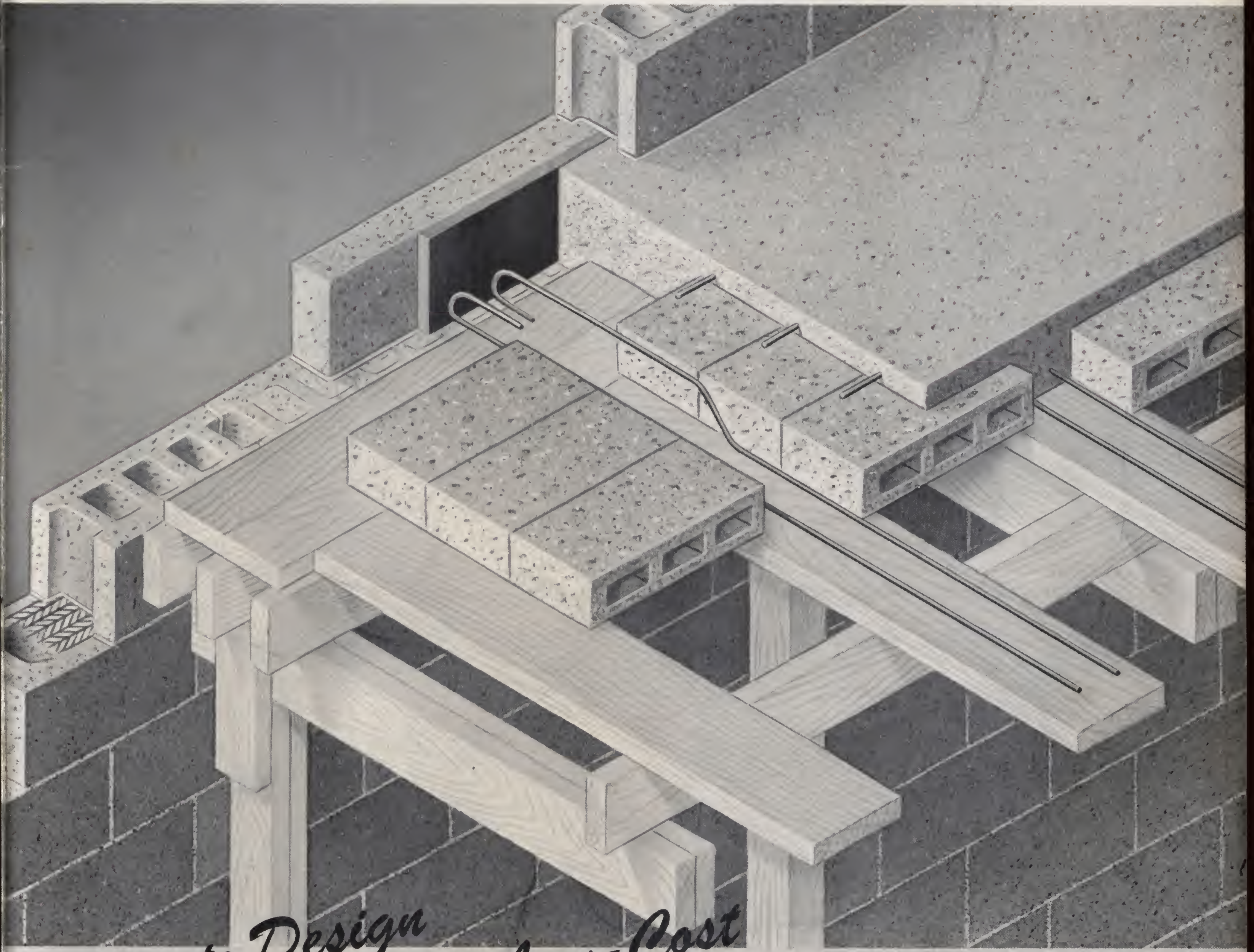

How to Design and Build Low-Cost

CONCRETE BLOCK JOIST FLOORS

for Residential and Other Light-Occupancy Buildings

PORTLAND CEMENT ASSOCIATION

FOREWORD

Designers and builders have found a construction-minded public quick to recognize the superiority of the concrete floor—its great strength and rigidity; its freedom from warping, shrinkage and squeaking; its protection against fire, rot and termite destruction; its longtime, trouble-free economy.

This booklet discusses the design and construction of concrete block joist floors and illustrates the method of design by a typical example. Allowable load tables based on the Building Code Requirements for Reinforced Concrete of the American Concrete Institute are included to assist the designer in selecting the proper reinforcement for a given load, span and size of joist. Where local code requirements differ, such differences must be taken into account by the designer.

The load tables may be helpful to the designer in denoting steel reinforcement requirements for concrete joist slabs using either plain or soffit type of block filler unit. The design of a soffit-type block filler unit incorporates an integral soffit with a block filler unit and provides a flat ceiling with a uniform acoustical or plastering surface.

Drawings and details in this booklet are not intended as final working drawings. It is recommended that every job be designed and built under supervision of a competent architect or structural engineer.

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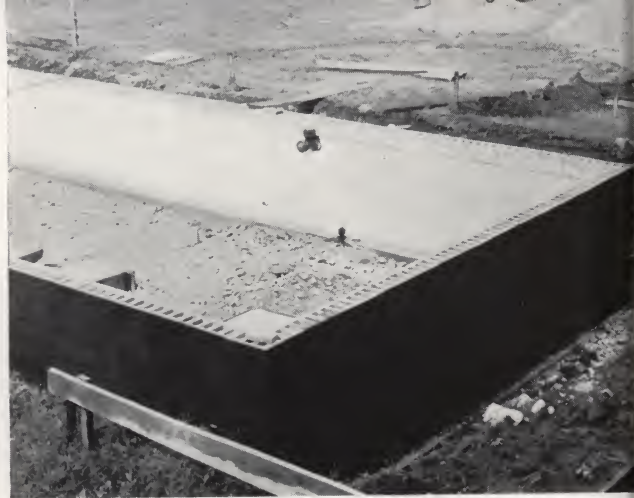


Build exterior walls to a floor height.

1

7 S

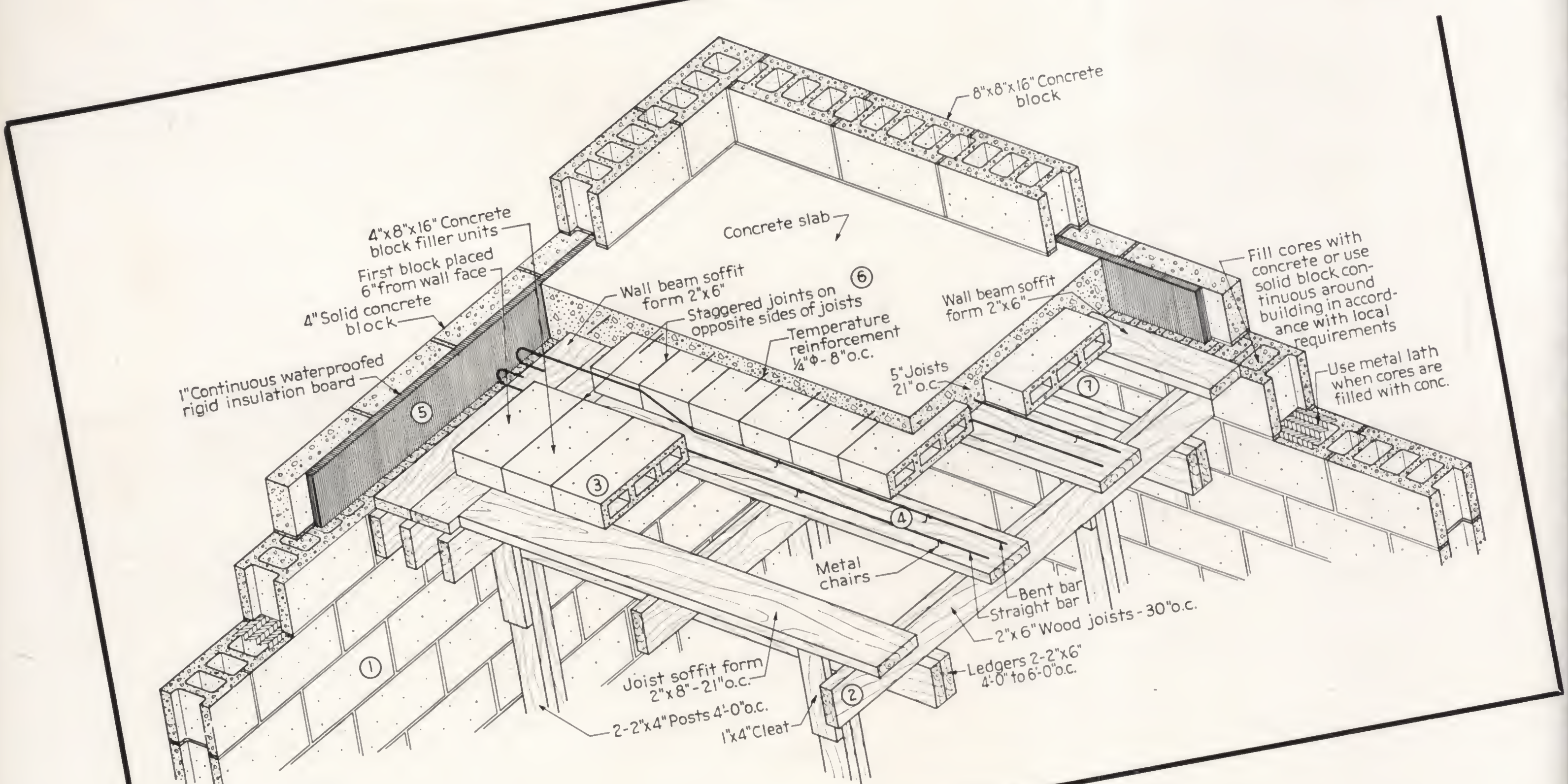
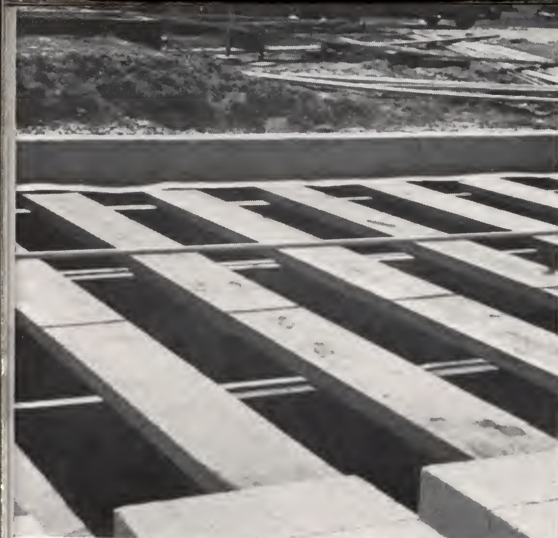


Fig. 1



Erect form work for supporting the filler units and concrete slab.

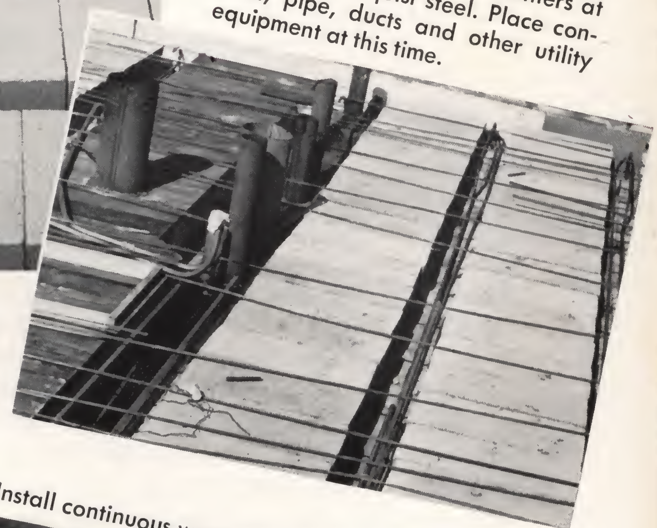
2 ⬆

Concrete block filler units placed so joints in adjacent rows are staggered.

3 ⬆

4 ➡

Place reinforcement for cast-in-place joist as determined from design table. Concrete slab reinforced with ¼-in. round bars 8 in. on centers at right angle to joist steel. Place conduits, pipe, ducts and other utility equipment at this time.



MPLE STEPS
in building a concrete block joist floor

5 ➡

Install continuous waterproofed rigid insulation board.

6 ➡

Place and finish concrete.

7 ⬇

Remove open deck forms after concrete has moist-cured 5 to 7 days.

CONCRETE BLOCK JOIST CONSTRUCTION

This type of concrete floor and roof construction combines precast concrete block and cast-in-place concrete slab and joists. The concrete block serve the dual purpose of forms for the joists of the floor and provide a flat ceiling which can be either plastered or painted direct. If concrete block filler units 15⅝ in. long are used, the design for this type of floor system requires a uniform spacing of joists 21 in. on centers. Thus the joists are actually 5⅜ in. wide. Joist depth is the overall thickness of the block filler unit and concrete slab. The dead load of this type of construction is considerably less than that of solid slab construction of equal load-carrying capacity. On the other hand the total depth of the floor has been increased.

This floor system is efficient and simple to build, requiring no special construction methods. Using concrete block as filler gives these advantages:

1. A flat ceiling, affording an excellent base for plaster or paint.
2. Substantial reduction of dead load as compared to solid slab construction of equal load-carrying capacity.
3. Improvement in heat insulation and sound absorption of the slab.
4. Minimum use of form lumber.
5. Excellent fire resistance.

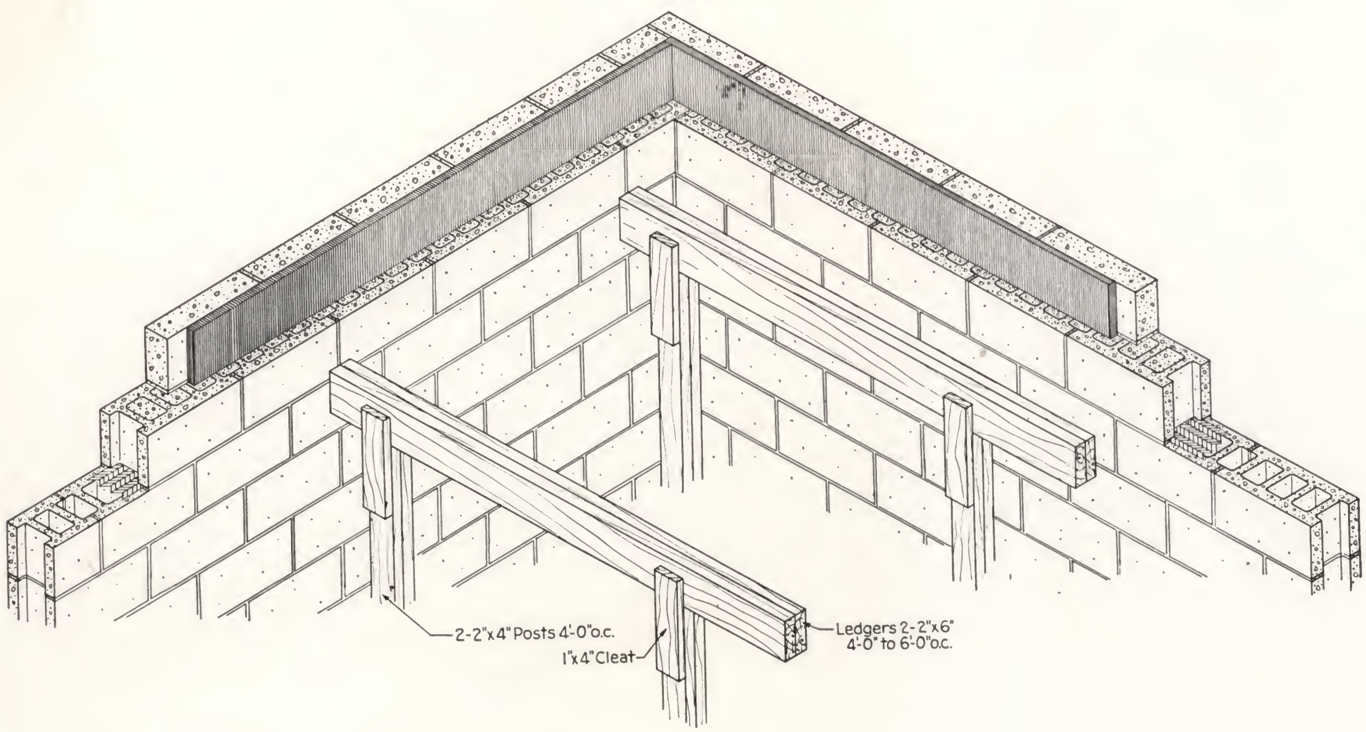
Steps in Construction

Concrete block joist floors are easily built with ordinary equipment. The important factors in the construction of this type of floor are adequate engineering design, average skill in erecting formwork and a general knowledge of good concrete construction. These essential requirements are outlined in this booklet.

Construction operations will become apparent as they are described (see Fig. 1). After the footings and foundation walls are in place, the exterior and intermediate bearing walls are built to a full story height. The next step is to erect the formwork. This completed, the concrete block filler units are so placed that the joints in adjacent rows are staggered or continuous, as required by the design. In the space between the rows of block the main reinforcement is fixed in position. At right angles to the main reinforcement, shrinkage and temperature steel is provided in the concrete slab.

Electrical, plumbing and heating facilities are then set in position. All conduits and pipe must be located so that the strength of the construction is not impaired. A 1-in. thick continuous, waterproofed rigid insulating strip is placed next to the exterior wall before the concrete floor slab is cast in place. This is recommended to

Fig. 2



lessen the edge heat loss by separating the concrete slab from the exterior wall.

The final operation is concreting. Care should be exercised to see that the essential factors for making quality concrete are observed. These may be summarized as follows:

1. Selection of suitable aggregates.
2. Design of mix for quality, workability, economy.
3. Accurate measurement of materials, including water.
4. Thorough mixing of the concrete.
5. Proper care in handling and placing to prevent segregation and to facilitate finishing.
6. Compacting concrete by spading, puddling or vibrating.
7. Adequate moist curing.

Formwork. The formwork required to support the concrete slab and filler block units is simple. Posts (two 2 x 4 in.) and ledgers (two 2 x 6 in.) are first erected, as shown in Fig. 2. The ledgers are cleated to the posts. The spacing of the posts or shores is 4 ft. 0 in. on centers; ledger spacing may vary between 4 ft. 0 in. and 6 ft. 0 in. Wood joists 2 x 6 in. are then laid on edge over and perpendicular to the ledgers. They are spaced from 24 in. to 30 in. on centers (Fig. 3). Joist soffit forms 2 x 8 in. which support the concrete block are erected next by placing them flatwise and in the same direction as the ledgers. The spacings of these forms must be exactly 21 in. on centers, as shown in Fig. 4. At bearing walls or partitions additional stringers are placed over the joists parallel to the bearing wall or partition to form the wall beam soffit, as shown in Fig. 4.

The same type of formwork can be used when building floors for depths of 4-in. block plus 2½-in. slab or 6-in. block plus 2½-in. slab. In the case of 4-in. plus 2½-in. construction an additional piece of lumber (1 x 2-in. filler) is nailed to the formwork supporting the beam which bears on the exterior wall, as shown in Fig. 5.

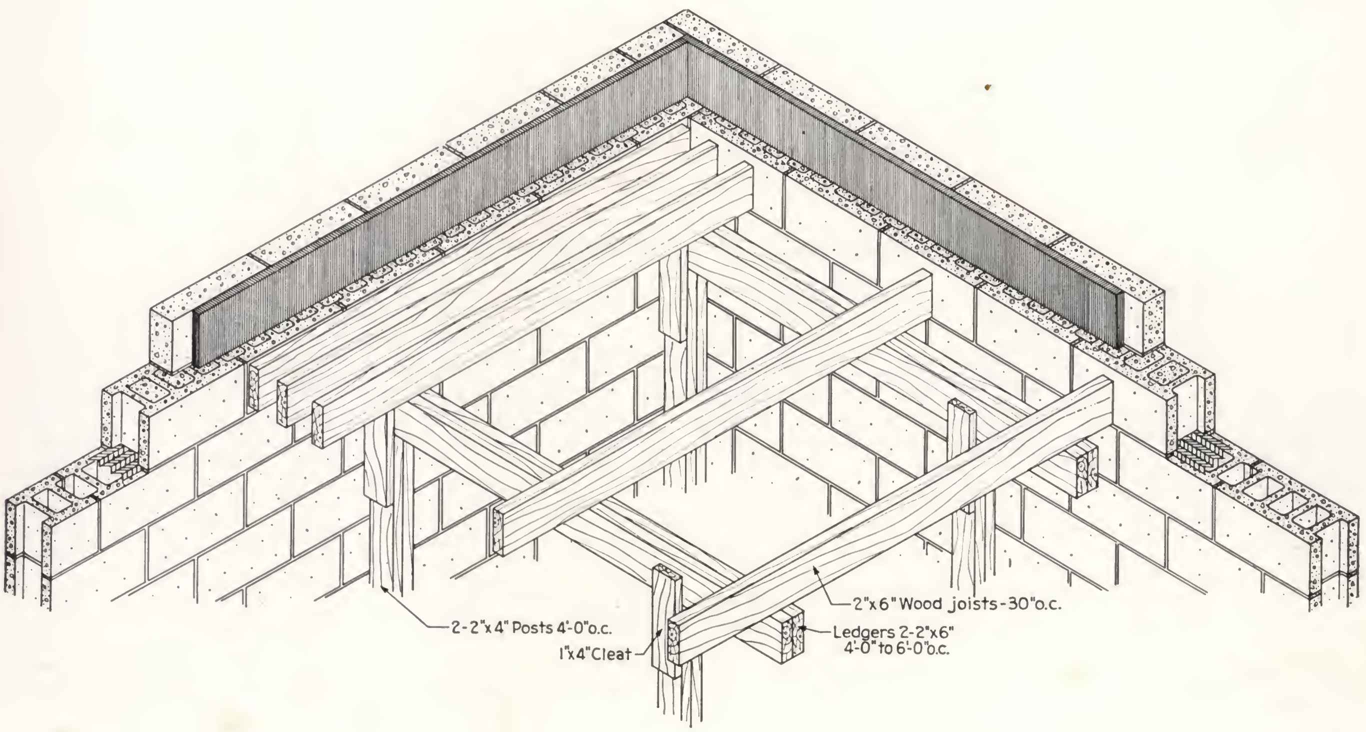
Among the miscellaneous forms required by practically all floors are those at stairwell openings and for stairs. Particular attention should be paid to the position of reinforcement where the stairs join the landing, as shown in Section GG, page 13. Conventional methods for building forms for reinforced concrete stairs are satisfactory, since so many different designs and shapes of formwork are applicable.

Forms must be stiff and well braced to carry safely the dead load of the concrete plus the live load applied during concreting. Formwork should be carefully planned as a means of keeping down costs and insuring a quality finish to the underside of the joists.

Provisions for Utilities. At the same time the formwork is being planned, consideration must be given to the installation of heating ducts, plumbing pipes, electrical conduits and other mechanical equipment.

Pipes or sleeves passing through a joist cannot be of such size or in such a location as to impair unduly the strength of the construction. (See Section BB, page 13.) Pipes which may be considered as replacing structurally the displaced concrete should be uncoated iron pipe or steel not thinner than standard wrought-iron pipe. The

Fig. 3



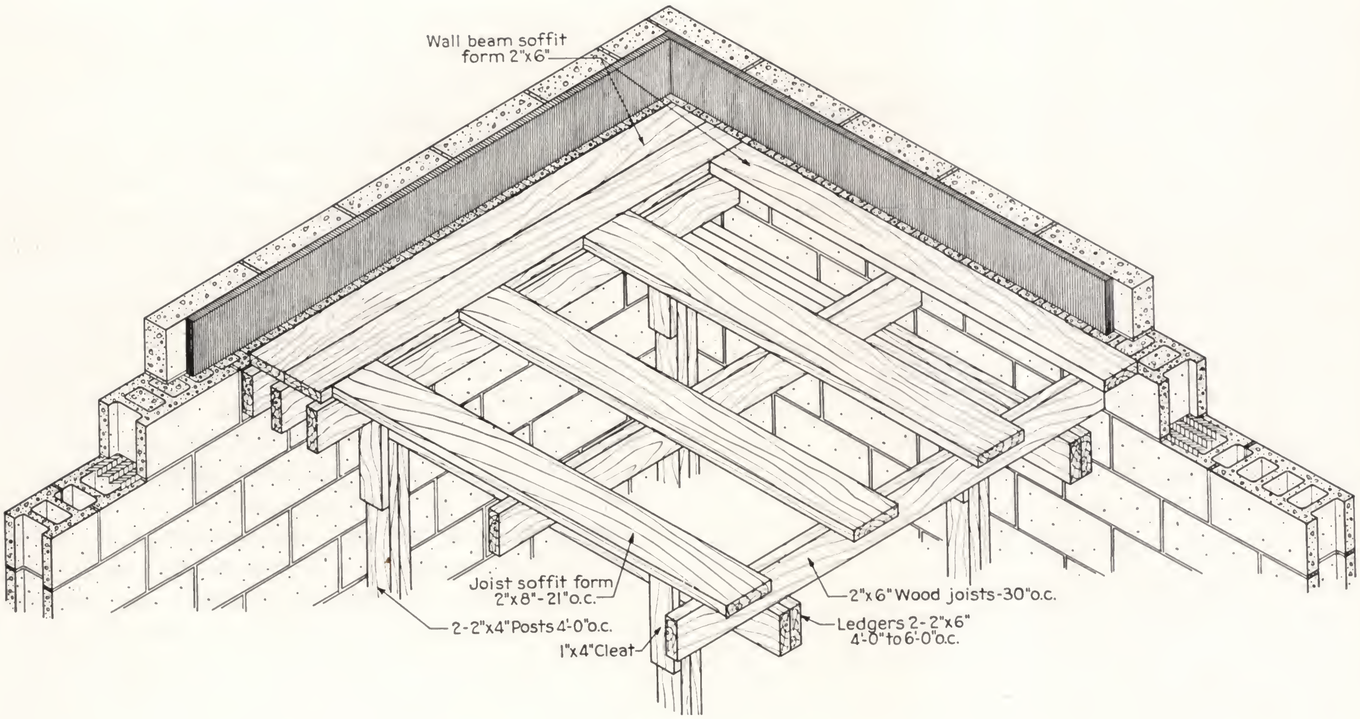


Fig. 4

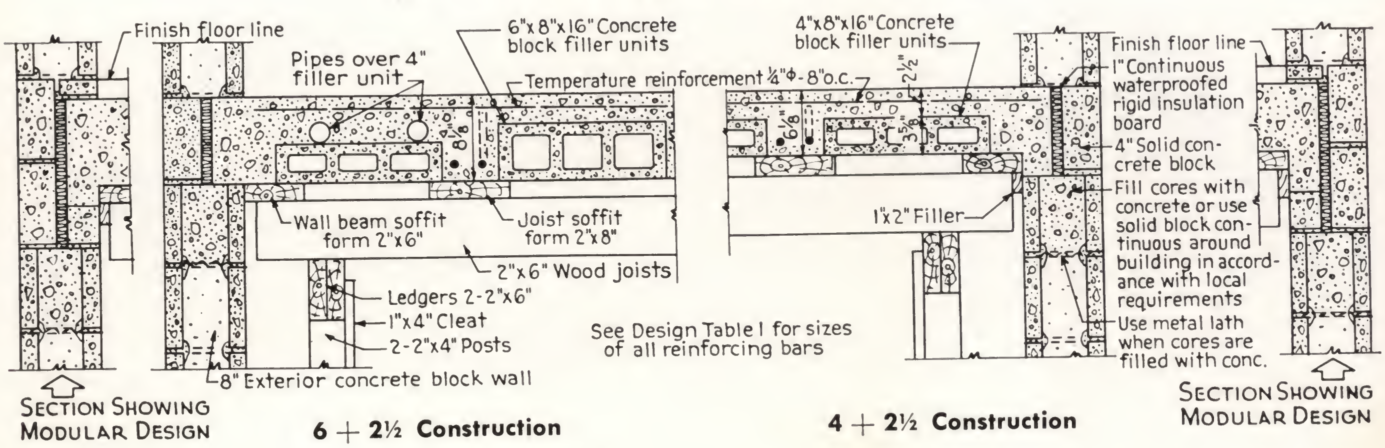
pipe should have a nominal inside diameter not larger than 2 in., and be spaced not less than three diameters on centers. Where pipe or conduits are embedded in the 2½-in. concrete slab, the outside diameter of such pipe or conduits cannot be greater at any point than 1½ in. If the pipe or conduits cross over one another the sum of their outside diameters is limited to 1½ in.

Methods for Placing Concrete Block Filler Units. Concrete block filler units span the openings between the 2 x 8-in. joist soffit forms (Fig. 1). Since these forms are accurately spaced 21 in. on centers, each filler unit will bear approximately 1⅛ in. on each soffit form.

To insure straight joists, care should be taken to maintain the concrete block accurately in line. Chalk lines are generally stretched between bearing supports directly over form boards to aid the workmen in placing the filler units.

In adjacent rows the joints between the concrete block filler units are placed either staggered or continuous, whichever is required by the design. The staggering of joints can be handled in one of two ways. At the start of each alternate row a half unit may be inserted or omitted. Where it is omitted the first full-sized unit in that row is offset by the amount of half a block (See Fig. 1.) For either staggered or continuous joints, the first block is placed not closer than 6 in. from the face of support.

Fig. 5 Detail at bearing wall. Plain type of filler block



6 + 2½ Construction **4 + 2½ Construction**

Experience in the field has shown that core openings in the filler units at each end of every row need not be covered during the concreting operation. The amount of concrete that would work into the core spaces is so small that it can be overlooked.

Allowable superimposed load tables are shown on pages 10 and 11, and cover two design assumptions regarding the placing of the filler units: staggered and continuous joints. With *staggered* joints the vertical shells of the filler units function as an integral part of the joist and are included in the calculations involving shear and negative bending moment. With this arrangement it is imperative that the compressive strength of the concrete block in pounds per square inch of net area be at least equal to that of the concrete used for the joist (2,500 lb. per sq. in.)

With *continuous* joints the vertical shells of the filler units cannot be included in the calculations; as a result the allowable load-carrying capacity may sometimes be considerably less for the same amount of reinforcement. No special provisions apply for the compressive strength of the concrete block placed with continuous joints other than that required by the local building codes.

Reinforcement. There are only two bars in each joist, and these are bent as shown in Fig. 7. Shrinkage and temperature reinforcement is provided in the concrete floor slab at right angles to the main reinforcement.

Bar chairs and slab spacers should always be used to hold the reinforcement in its correct position in the concrete joist and slab. It will prove less expensive to use the standard type of accessories developed for this purpose than to depend on field expedients.

Soffit-type Filler Block. Construction methods for the soffit-type filler block floor (see Fig. 6) is almost identical to that used for the plain-type of filler block floor.

Intermediate Support. Ordinarily when the span length exceeds 15 ft. between bearing walls, the plan should call for an intermediate support. A concrete masonry wall in a basement may serve as an intermediate support for the first floor and will provide a divided basement at very little additional cost.

Bearing partitions which carry the upper floors or roof should come over the intermediate support. Where the design cannot permit this condition, special beams will have to be erected under the bearing partition.

Strength and Mix Proportion of Concrete in Slab and Joist. Concrete for the beams, joist and floor slab should have an average compressive strength of not less than 2,500 lb. per sq. in. at the age of 28 days when tested in accordance with the "Standard Method of Tests for Compressive Strength of Molded Concrete Cylinders" (ASTM Designation: C39).

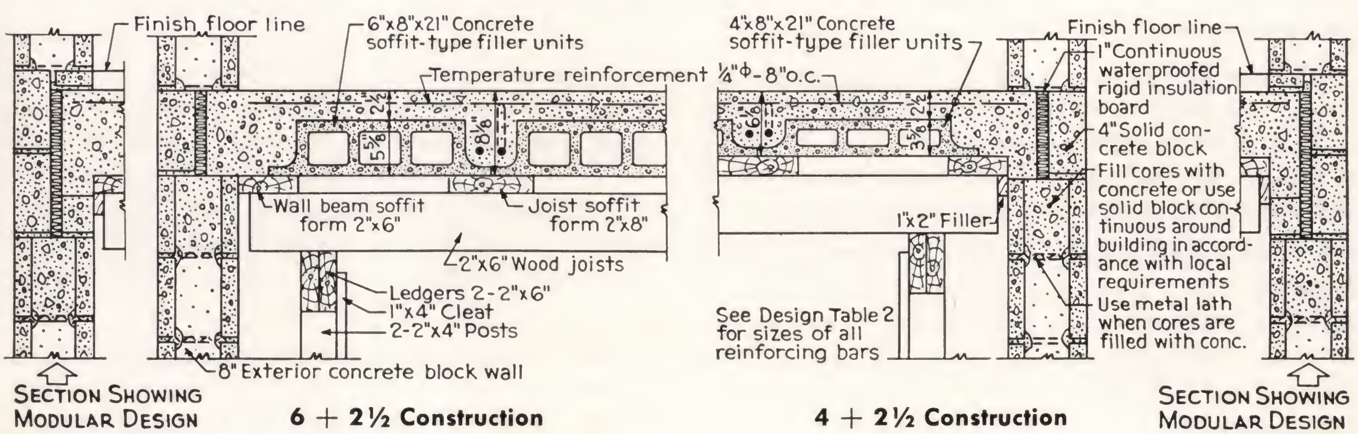
Concrete should be made of hard, well-graded aggregate which conforms to ASTM Designation: C33, "Specifications for Concrete Aggregates." It should contain not more than 6¾ gal. of water for each sack of cement. It should be of a plastic mix which can be placed without honeycomb or accumulation of excess water on the surface.

Such a mix will consist of approximately 1 volume of portland cement; 2½ volumes of fine aggregate, well graded from ¼ in. down; and 3½ volumes of coarse aggregate, well graded in size from ¼ in. to 1 in.

Placing Concrete in Forms. Before placing operations begin, preliminary checks should be made. These include a final inspection of the placing of the steel. Special attention should be given to providing proper protective covering of the steel and to placing accessories to hold the steel in position so that it will not be displaced during concreting. The forms are also checked as to location and adequacy of bracing.

The concrete should be deposited in the forms in level courses and carefully spaded or vibrated into place. Placing methods should be such as to avoid segregation

Fig. 6 Detail at bearing wall. Soffit-type of filler block



of the materials and to provide a dense, homogeneous concrete free from honeycomb.

Finishing. For an even surface, the concrete, after being struck off to proper grade, should be worked with a wood float in a manner which will compact the surface and leave no depressions. After the concrete has hardened enough to prevent fine material from working to the top—when the sheen or shiny film of water on the surface has disappeared—it should be steel troweled, but excessive troweling should be avoided.

Concrete Floor Finishes. Practically any type of finish can be applied to or on a concrete subfloor. In specifying floor finishes the architect should always designate the thickness of finish or covering to be used so that the contractor can build the concrete subfloor to proper elevation.

Color may be applied on exposed concrete surfaces by any of the following methods: (1) by using a concrete topping at least 1 in. thick in which a mineral pigment has been mixed; (2) by dusting on a dry mixture of portland cement and a pigment; (3) by applying inorganic dyes or stains directly to the finished concrete surface; and (4) by painting with paints prepared for the purpose. Before a concrete floor is painted it should be allowed to dry thoroughly for 5 to 6 weeks; then all dirt must be removed and the surface neutralized by brushing on a solution of zinc sulfate. A uniform color can be obtained by the dust-on method if the floor area to be colored is subdivided into relatively small sections. Each section is worked upon individually. The dust-on mixture is applied evenly over the surface in proportion of not less than 1¼ lb. per sq. ft.

Hard surfacings include terrazzo, concrete tile, art marble, ceramics, marble mosaics and slate. When such surfaces, except terrazzo, are desired, the concrete subfloor is brought to a specified elevation below final grade to allow for the thickness of the floor covering and the setting bed. It is recommended that directions for laying given by manufacturers and distributors of these floor surfacing materials be followed closely.

Where wood-surfaced floors are desired, creosoted 2x3-in. sleepers with beveled edges should be set on 16-in. centers as nailing strips for the floor. Sleepers should be accurately leveled and set in the concrete floor slabs or attached to the slab by metal clips.

Linoleum, rubber, cork or asphalt tile, and carpet are common types of floor coverings. These, except for carpet, are cemented to the concrete. In every case manufacturers' specifications for preparing the surface and instructions for laying the floor material should be followed carefully.

For additional information, see Portland Cement Association's publication, *Suggested Specifications for Applying Finishes and Coverings on Concrete Residence Floors.*

Removal of Forms. Forms must be left in place long enough to allow the concrete to gain sufficient strength to support its own weight plus that of any construction loads. Building materials or equipment should not be allowed on floors until supports or shores are replaced. This should be done immediately after forms are removed.

Border Strip Insulation. A continuous waterproofed rigid insulation strip 1-in. thick should be provided between the exterior masonry wall and the edge of the concrete floor slab. Recent studies by the National Bureau of Standards have indicated that this edge insulation is very important. Insulating the concrete floor at the edge is beneficial both in saving heat and in reducing ateral temperature gradients across the floor.

Curing. Curing is very important in constructing concrete floors. Moist burlap or canvas or waterproofed concrete curing paper may be used to cover the floor slab. Burlap or canvas coverings are kept constantly wet for at least 7 days when normal portland cement is used or at least 3 days when high-early-strength portland cement is used. The covering should be placed as soon as it can be done without marring the surface of the concrete.

Cold Weather Requirements.

In early winter, when freezing temperatures occur only at night, it is necessary to protect concrete from freezing only after it is in place. As the weather grows colder and freezing temperatures prevail, the mixing water and aggregates are heated and the work protected as well. Concrete is placed immediately after mixing to prevent loss of heat. As soon as it is placed, it is protected to retain the heat. Concrete floors can be protected by covering with heavy paper followed by 10 or 12 in. of hay or straw. Too early removal of forms is to be guarded against when concreting in cold weather. It is recommended that forms remain in place until the concrete has attained sufficient strength to sustain its own weight in addition to any other load that may be placed upon it during construction.

More complete information on this subject is given in the concrete information sheet, *Concreting in Cold Weather* prepared by the Portland Cement Association.

DESIGN DATA FOR TABLES 1 AND 2

Design is based on the American Concrete Institute Building Code Requirements for Reinforced Concrete (ACI 318-47) except that the coefficient for positive moment in end spans is assumed to be $\frac{1}{11}$ instead of $\frac{1}{14}$. Allowable unit stresses are:

$f_s = 20{,}000$ psi.

$f_c = 1125$ psi. ($f'_c = 2500$ psi.)

$v_c = 50$ psi. (interior support—ordinary anchorage)

$v_c = 75$ psi. (end support—special anchorage)

$u = 125$ psi. (interior support—ordinary anchorage)

$u = 188$ psi. (end support—special anchorage)

All bars are round and deformed. Ends of all bars are hooked for exterior supports. No hooks are required at interior supports.

Vertical shells of filler block in contact with the joists have been assumed to be 1 in. thick. Thus 2 inches have been added to the effective width of the joists when the joints between the block are staggered in adjacent rows of filler block and when the compressive strength of the block is at least 2500 psi. on the net area. If the filler block do not meet this strength requirement, or if the joints in adjacent rows are not staggered, no portion of the filler may be included in the design calculations. Allowable superimposed load values are given in Tables 1 and 2 for both conditions.

Concrete filler block shall be placed not closer than 6 in. from face of support.

Values shown in Tables 1 and 2 are based on filler block made of lightweight concrete. In Table 1 on plain-type filler units, the 4 x 8 x 16-in. block are assumed to weigh 15 lb. each and the 6 x 8 x 16-in. block to weigh 18 lb. For Table 2 on soffit-type filler units, the 4 x 8 x 21-in. block are assumed to weigh 17 lb. each and the 6 x 8 x 21-in. block to weigh 20 lb. For block weighing more than these assumed weights the allowable superimposed load values should be reduced by the difference between the actual and assumed weights expressed in pounds per square foot.

The load values shown in Tables 1 and 2 for multiple spans are based on the assumption that adjacent spans have the same length. These load values may still be used provided the larger of two adjacent spans does not exceed the shorter by more than 20 per cent. See illustrative problem on page 12 for procedure in case of unequal span lengths.

The maximum allowable deflection is limited to $\frac{L}{360}$. The deflection was computed from the following formula which includes the effect of sustained loading:

$$\triangle = \frac{5}{384} \times \frac{1728L^4}{I} \left[\frac{W_{LL}}{E_c} + \frac{W_{DL}}{E_r} \right]$$

where,

$\triangle$ = Ultimate deflection in inches.

L = Clear span in feet.

I = Moment of inertia in in.^{4} based on T-beam section using gross concrete area plus transformed area of steel.

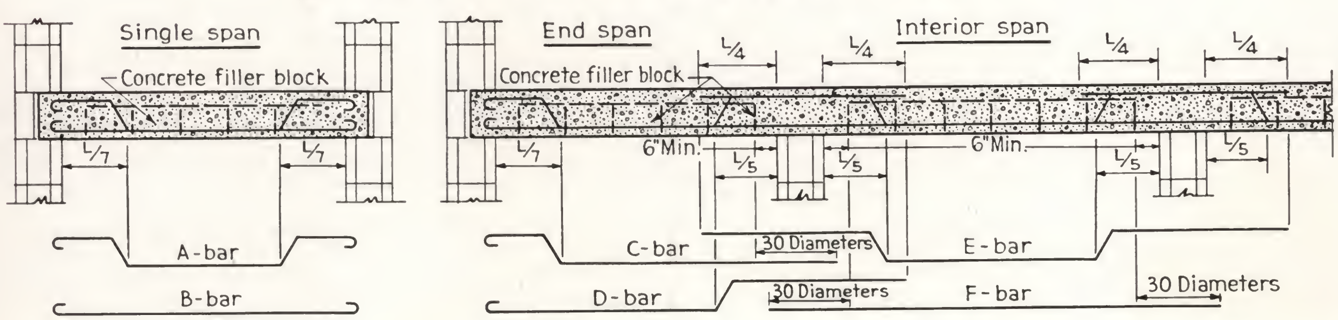
E_c = Secant modulus of elasticity of concrete $= 1000\ f'_c = 2.5 \times 10^6$ psi.

E_r = Reduced modulus of elasticity of concrete $= 700{,}000$ psi.

W_{LL} = Live load in lb. per sq. ft.

W_{DL} = Dead load in lb. per sq. ft.

Fig. 7 Shapes of bars used in reinforcing single and multiple span floors



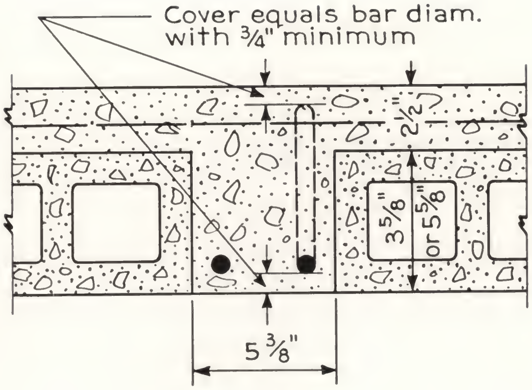


Fig. 8

TABLE 1

ALLOWABLE SUPERIMPOSED LOADS IN POUNDS PER SQUARE FOOT FOR FLOORS WITH PLAIN-TYPE CONCRETE FILLER BLOCK.

Allowable superimposed loads are the loads that the floor can safely support in addition to the weight of the floor slab, joist and filler block.

See Design Data (page 9) for additional information.
See Fig. 7 for shapes of bars.
Designed for joists spaced 21 in. on centers.

Spans	Nominal Depth of Slab in.	Weight of Floor† psf.	Reinforcement bars						Allowable Superimposed Loads**								
									Clear Span L in Feet								
			A	B	C	D	E	F	10	11	12	13	14	15	16	17	18
Single Span	4 + 2½	55	⅜	½					**57** 57	**38** 38							
			⅜	⅝					**98** 98	**68** 68	**48** 48	**33**					
			½	⅝					**123** 123	**93** 93	**69** 69	**50**					
			½	¾					**150** 150	**128** 128	**98** 90*	**70*** 37*					
			⅝	¾						**150** 150	**123** 107*	**79*** 42*					
	6 + 2½	65	⅜	½					**93** 93	**65** 65	**45** 45						
			⅜	⅝					**148** 148	**111** 111	**83** 83	**61** 61	**43** 43				
			½	⅝						**144** 144	**110** 110	**84** 84	**64** 64	**47** 47			
			½	¾							**150** 150	**120** 120	**94** 94	**74** 74	**57** 51*	**38***	
			⅝	¾								**149** 149	**119** 119	**96** 96	**76** 59*	**43***	
			⅝	⅞									**150** 150	**128** 128	**105** 71*	**53***	
			¾	⅞										**150** 145*	**118*** 80*	**60***	
Two Spans	4 + 2½	55			⅜	½			**96** 76	**70** 63	**50** 50	**35** 35					
					½	⅝			**119** 70	**101** 57	**87** 47	**75** 39	**60** 32	**46**			
	6 + 2½	65			⅜	½			**153** 122	**115** 103	**86** 86	**64** 64	**46** 46	**32** 32			
					⅜	⅝					**135** 84	**107** 71	**84** 61	**65** 52	**49** 44	**37** 37	
					½	⅝					**140** 84	**123** 71	**109** 61	**92** 52	**73** 44	**57** 37	**44** 31
Three or More Spans	4 + 2½	55			⅜	⅜	⅜	⅜	**42** 42	**25** 25							
					⅜	½	½	⅜	**99** 77	**73** 65	**52** 52	**36** 36					
					½	½	½	⅜	**108** 77	**84** 65	**62** 53	**44** 44	**31** 31				
					½	⅝	⅝	½	**119** 70	**101** 57	**87** 47	**75** 39	**65** 32	**55**	**42**		
	6 + 2½	65			⅜	½	½	⅜	**151** 122	**113** 103	**85** 85	**63** 63	**45** 45	**31** 31			
					½	½	½	⅜		**134** 103	**102** 88	**77** 75	**58** 58	**42** 42			
					½	⅝	⅝	½			**140** 84	**123** 71	**109** 61	**88** 52	**70** 44	**54** 37	**41** 31
					⅝	¾	¾	⅝			**135** 80	**118** 68	**104** 57	**92** 49	**81** 41	**72** 34	**64** 28

†Weight assumed for floor slab, joist and filler block.

*Values limited by maximum deflection of $\frac{L}{360}$. All other load values governed by shear or moment.

Use values in **bold-face type when joints between filler block are staggered in adjacent rows of block. In this case, filler block must have a compressive strength of at least 2500 psi. on the net area. Use values in light-face type when joints are continuous (not staggered) in adjacent rows of filler block.

TABLE 2

ALLOWABLE SUPERIMPOSED LOADS IN POUNDS PER SQUARE FOOT FOR FLOORS WITH SOFFIT-TYPE CONCRETE FILLER BLOCK.

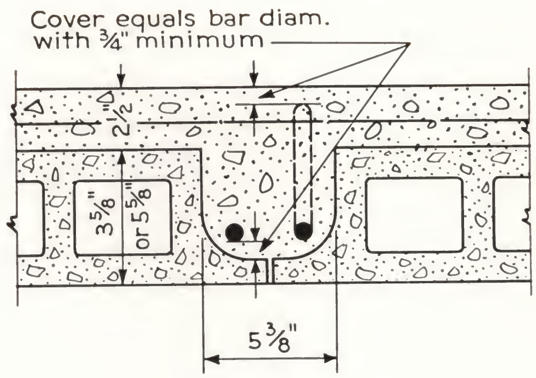


Fig. 9

Head and footnotes are same as for Table 1, page 10.

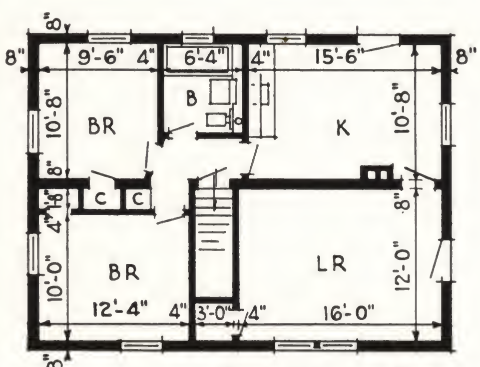
Spans	Nominal Depth of Slab in.	Weight of Floor† psf.	Reinforcement bars A	B	C	D	E	F	Allowable Superimposed Loads** Clear Span L in Feet 10	11	12	13	14	15	16	17	18
Single Span	4 + 2½	55	⅜	½					34 34								
			⅜	⅝					62 62	42 42							
			½	⅝					86 86	62 62	43 43						
			⅝	⅝					96 96	82 82	63 56*	38*					
			½	¾					116 116	88 88	65 56*	38*					
			⅝	¾					123 123	107 107	85 60*	40*					
	6 + 2½	65	⅜	½					69 69	46 46	28 28						
			⅜	⅝					113 113	83 83	59 59	40 40					
			½	⅝					149 149	113 113	84 84	61 61	44 44	30 30			
			½	¾						150 150	118 118	91 91	70 70	52 52	38 38		
			⅝	¾							148 148	116 116	92 92	71 71	55 29*		
			⅝	⅞								150 141	121 121	97 92*	78 35*		
			¾	⅞									146 125	119 99*	83* 41*	31*	
			⅞	⅞										140 108*	88* 48*	36*	
Two Spans	4 + 2½	55			⅜	⅜			34 34								
					⅜	½			68 68	46 46	30 30						
					½	½			74 74	63 63	51 48	35 32					
	6 + 2½	65			⅜	½			120 117	88 88	64 64	44 44					
					½	½			130 116	112 98	84 80	61 59	44 42	30			
					½	⅝				150 92	132 78	109 66	85 56	66 47	50 39	37 33	
					⅝	⅝				150 91	132 77	117 65	97 55	76 46	59 38	45 32	33
					⅝	¾				148 87	128 73	112 62	99 52	87 43	77 36	68 30	60
Three or More Spans	4 + 2½	55			⅜	⅜	⅜	⅜	34 34								
					⅜	½	½	⅜	68 68	46 46	30 30						
					½	½	½	⅜	74 74	63 63	53 53	38 38					
	6 + 2½	65			⅜	½	½	⅜	120 117	88 88	64 64	44 44					
					½	½	½	⅜	130 116	112 98	97 83	75 71	55 53	40 38			
					½	⅝	⅝	½		150 92	132 78	109 66	85 56	66 47	50 39	37 33	
					⅝	⅝	⅝	½		150 91	132 77	117 65	104 55	91 46	73 38	57 32	44
					⅝	¾	¾	⅝		148 87	128 73	112 62	99 52	87 43	77 36	68 30	60

ILLUSTRATIVE PROBLEM

Concrete block joist floors are designed with either plain or soffit-type filler units. In this problem the block are assumed to be of the plain type and placed so that the joints between the block in adjacent rows are staggered. The floor plans for this problem are shown below and detailed sections are shown on page 13.

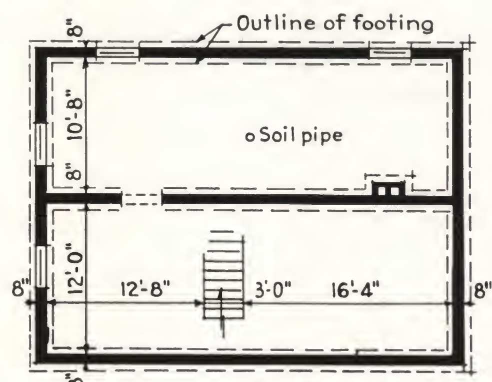
The superimposed floor loads in this problem are assumed to be as follows:

Live load	= 40 lb. per sq. ft.
Floor finish	= 5 lb. per sq. ft.
Partitions	= 22 lb. per sq. ft.
Total	= 67 lb. per sq. ft.



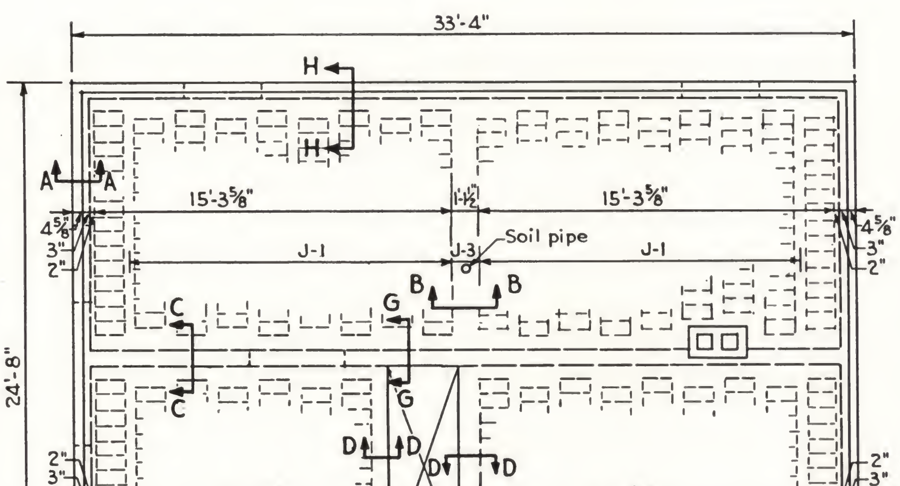
FIRST FLOOR PLAN

Fig. 10



BASEMENT PLAN

Fig. 11



FLOOR FRAMING PLAN

Fig. 12

Illustrative Problem—continued

Partition loads are considered to be uniformly distributed because this type of floor distributes concentrated loads laterally into adjacent joists.

The 8-in. bearing wall shown in the basement plan furnishes an intermediate support for the floor. This provides two-span construction for the joists in the sections designated J-1 and J-2 in the floor framing plan. In sections J-1 the span is 10 ft. 8 in. or nominally 11 ft. and in sections J-2 the span is 12 ft. 0 in.

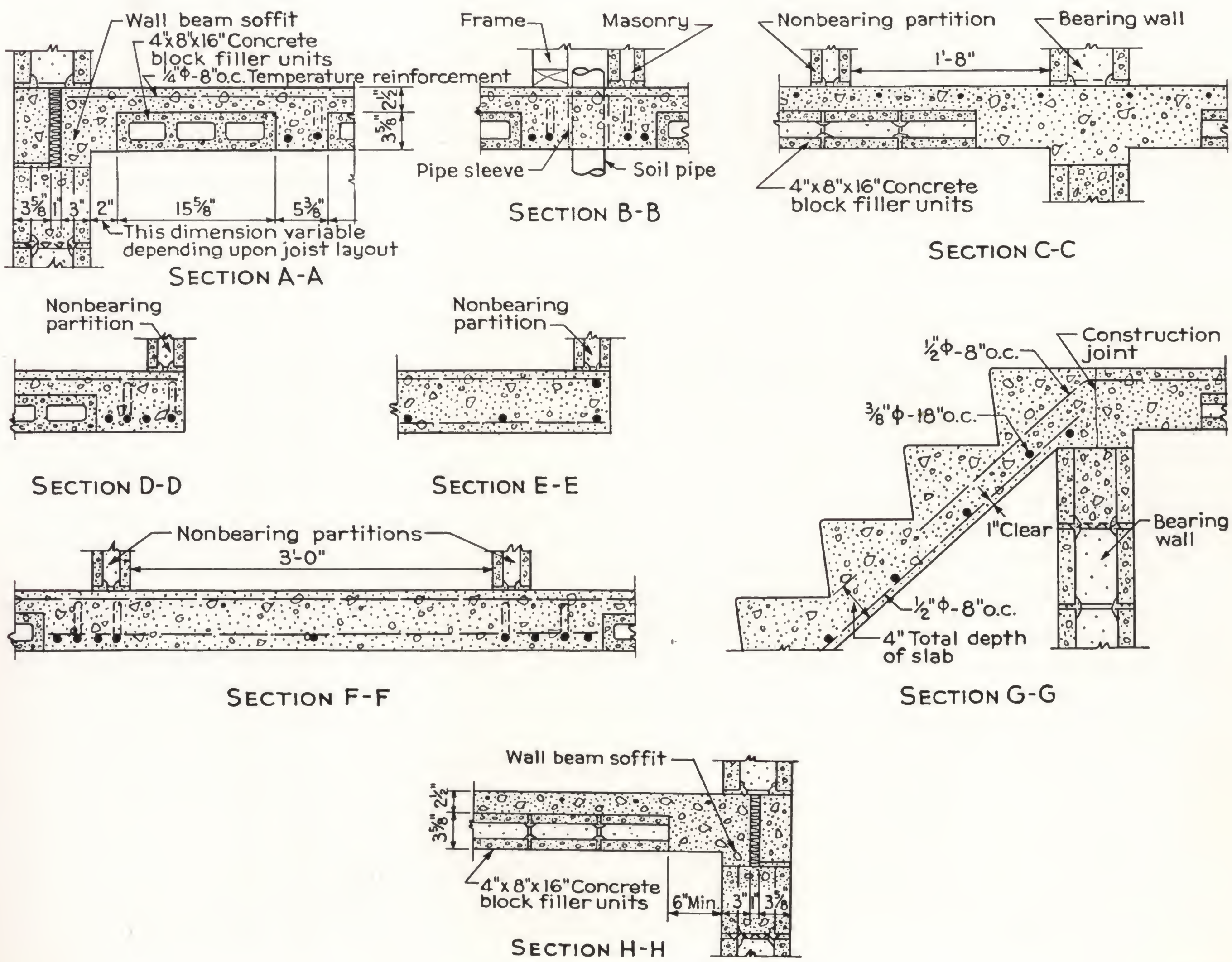
Table 1 indicates that for two-span construction a 4+2½-in. floor slab on an 11 ft. span will support a load of 70 lb. per sq. ft. with a ⅜-in. C-bar and a ½-in. D-bar. For the same 4+2½-in. floor slab, a 12-ft. span will support a load of 87 lb. per sq. ft. with a ½-in. C-bar and a ⅝-in. D-bar. Both the 70- and 87-lb. loads are above the 67-lb. load to be carried. The bars for each span are bent as shown in the details for "End span" construction in Fig. 7.

The joist J-3 under the right-hand partition of the bathroom has been widened to 13½ in. to accommodate the utilities for the bathroom (Section B-B). The two joists framing the stair opening (Section D-D) and directly under the partitions have also been widened to permit the use of additional reinforcing steel. It is customary in these cases to use twice the steel required for a single joist and to widen the joist to approximately twice its normal width.

In small floor panels such as at the ends of stair openings (Sections E-E and F-F) it may be more convenient to omit the filler block.

The distance between the last row of filler block at each end of the floor is shown in this problem to be 2 in. (Section A-A). It may, however, be more or less than 2 in. depending on the space needed to close the gap between the foundation wall and the nearest row of blocks.

Fig. 13



SUGGESTED SPECIFICATIONS FOR CONCRETE BLOCK JOIST FLOORS

for residential and other light-occupancy buildings

1. GENERAL

The concrete contractor shall provide all materials, labor and equipment required to complete the concrete floors of this project in accordance with the plans and specifications. The work shall be properly coordinated with that of other trades. All local laws and ordinances applicable to this work shall be fully complied with.

2. MATERIALS

Portland Cement. Portland cement shall conform to the "Standard Specifications for Portland Cement" (ASTM Designation: C150).

Concrete Aggregates. Concrete aggregates shall conform to the "Standard Specifications for Concrete Aggregates" (ASTM Designation: C33). The maximum size of aggregate shall be not more than one-fifth of the narrowest dimension between forms nor larger than three-fourths of the minimum clear spacing between reinforcing bars.

Water. Water used in mixing concrete shall be clean, and free from injurious amounts of oils, acids, alkalies, organic materials or other deleterious substances.

Metal Reinforcement. Reinforcing bars shall conform to the requirements of the "Standard Specifications for Billet-Steel Bars for Concrete Reinforcement" (ASTM Designation: A15), or "Standard Specifications for Rail-Steel Bars for Concrete Reinforcement" (ASTM Designation: A16), or "Standard Specificcations for Axle-Steel Bars for Concrete Reinforcement" (ASTM Designation A62.)

Cold-drawn wire or welded wire fabric for concrete reinforcement shall conform to the requirements of the "Standard Specifications for Cold-Drawn Steel Wire for Concrete Reinforcement (ASTM Designation: A82), or "Standard Specifications for Welded Steel Wire Fabric for Concrete Reinforcement" (ASTM Designation: A185).

Storage of Materials. Cement and aggregates shall be stored in such a way as to prevent deterioration or intrusion of foreign matter. Any material which has deteriorated or which has been damaged shall not be used for concrete.

Concrete Block Filler Units. These shall conform to the physical requirements (compressive strength, absorption and moisture content) of the local building code for concrete masonry units. In the absence of a local building code the current ASTM specifications covering the particular use or construction in which units are employed shall apply. The filler units shall be in a dry condition when delivered to the building site and shall be protected against wetting prior to being set upon the forms.

Where the plan calls for the joints to be staggered in adjacent rows, the net compressive strength of the concrete block shall be at least equal to that of the adjoining concrete joist. (2,500 lb. per sq. in.)

Fiber Insulating Board. Fiber insulating board shall conform to Federal Specifications *LLL-F*-32 lb. It shall be 1-in. thick and coated on all sides and edges with asphalt to prevent moisture absorption.

3. STRENGTH AND MIX PROPORTION OF CONCRETE IN SLAB AND JOIST

Compressive Strength. Cast-in-place concrete for slab and joist shall have an average compressive strength of not less than 2,500 lb. per sq. in. at 28 days. Under no conditions shall there be more than 6¾ gal. of mixing water used per sack of cement.

Concrete Proportions and Consistency. Concrete shall be machine mixed in the approximate proportion of 1 volume of portland cement, 2½ volumes of sand and 3½ volumes of coarse aggregate (1:2½:3½). This proportion may be varied slightly to produce the workability required in the following paragraph, but in no case shall more than 6¾ gal. of water, including the free moisture contained in the aggregate, be used per sack of cement.

The proportions of aggregate to cement for any concrete shall be such as to produce a mixture which will work readily into the corners and angles of the forms and around reinforcement with the method of placing employed on the work, but without permitting the materials to segregate or excess free water to collect on the surface. The combined aggregates shall be of such composition of sizes that when separated on the No. 4 standard sieve, the weight passing the sieve (fine aggregate) shall not be less than 30 per cent nor greater than 50 per cent of the total unless otherwise required by the architect or engineer, with the exception that these proportions do not necessarily apply to lightweight aggregates.

The methods of measuring concrete materials shall be such that the proportions can be accurately controlled and easily checked at any time during the work. Wherever practicable the architect or engineer should require measurement by weight rather than by volume. Measurement of materials for ready-mixed concrete shall conform to the "Standard Specifications for Ready-Mixed Concrete" (ASTM Designation: C94).

4. MIXING, PLACING AND CURING OF CONCRETE

Preparation of Equipment and Place of Deposit. Before placing concrete, all equipment for mixing and transporting the concrete shall be cleaned, all debris and ice shall be removed from the spaces to be occupied by the concrete, forms shall be thoroughly wetted (except in freezing weather) or oiled, and concrete block filler units that will be in contact with the concrete shall be moistened (except in freezing weather), and the reinforcement shall be thoroughly cleaned of ice or other coatings.

Mixing of Concrete. The concrete shall be mixed until there is a uniform distribution of the material and shall be discharged completely before the mixer is recharged.

For job-mixed concrete, the mixer shall be rotated at a speed recommended by the manufacturer and mixing shall be continued for at least one minute after all materials are in the mixer. A longer mixing period may be required for mixers larger than one cubic yard capacity.

Ready-Mixed concrete shall be mixed and delivered in accordance with the requirements set forth in the "Standard Specifications for Ready-Mixed Concrete" (ASTM Designation: C94).

Conveying. Concrete shall be conveyed from the mixer to the place of final deposit by methods which will prevent the separation or loss of material.

Depositing. Concrete shall be deposited as nearly as practicable in its final position to avoid segregations due to rehandling or flowing.

When concreting is once started, it shall be carried on as a continuous operation until the placing of the section is completed.

All concrete shall be compacted by suitable means and shall be thoroughly worked into all corners of the forms. However, if it is necessary to stop work, construction joints in floors shall be located near the middle of the spans and at right angles to the joists or main reinforcing steel.

Curing. Concrete made with normal portland cement shall be maintained in a moist condition for at least the first seven days after placing and high-early-strength concrete shall be so maintained for at least the first three days.

Cold Weather Requirements. Adequate equipment shall be provided for heating the concrete materials and protecting the concrete during freezing or near freezing weather. No frozen materials or materials containing ice shall be used.

All concrete materials and reinforcement, forms and filler units with which the concrete is to come in contact shall be free from frost. Whenever the temperature of the surrounding air is below 40 deg. F., all concrete when placed in forms shall have a temperature of between 70 and 80 deg. F. and shall be maintained at a temperature of not less than 50 deg. F. for at least 72 hours for normal concrete or 24 hours for high-early-strength concrete, or for as much time as is necessary to produce the required compressive strength of 2,500 lb. per sq. in.

5. FORMS AND DETAILS OF CONSTRUCTION

Design of Forms. Forms for supporting concrete block filler units shall conform to shape, lines and dimensions of the members as called for on the plans, and shall be substantial and sufficiently tight to prevent leakage of mortar. They shall be designed to resist the pressure to which they are subjected. Forms shall be properly placed and tied together so as to maintain position and shape.

Removal of Forms. Forms shall be removed in such a manner as to insure the complete safety of the structure. In no case shall the supporting forms or shoring be removed until the concrete members have acquired sufficient strength to support safely their weight and the load thereon.

Provision for Utilities. Contractor shall provide the necessary headers and boxes required for sleeves and openings by the mechanical trades. Size and location of such headers and openings shall be determined by the mechanical contractors.

Electrical contractor shall furnish the general contractor with the location and size of all headers and openings necessary in the formwork for his contract. He shall place conduit, outlet boxes, etc., to be embedded in the slab, on the forms well in advance of placing concrete and provide sleeves for conduits which pass through slabs.

Heating and plumbing contractor shall furnish the general contractor with the location and size of all headers and openings necessary for his work. He shall place all pipe and other equipment, to be embedded in the slab, well in advance of placing concrete and provide sleeves for pipe which will pass through slabs.

Placing Concrete Block Filler Units. These units shall be set on the forms with joints either staggered or continuous in adjacent rows as indicated on the plans. The spacing of these units within each row shall be such as to provide proper width of the joist. The bearing edges of the filler units shall be butted together to prevent mortar leakage.

Placing Reinforcement. Contractor shall furnish and install reinforcement of size and spacing shown on plans. Reinforcement shall be securely wired in position and care taken to prevent its displacement during construction. All reinforcement shall be supported on suitable chairs and spacers. The ends of all straight and bent joist bars shall be provided with standard hooks at the ends of single spans and outer ends of continuous spans.

Concrete Protection for Reinforcement. The metal reinforcement shall be protected by the thickness of concrete indicated in the plans.

Exposed reinforcement bars intended for bonding with future extensions shall be protected from erosion by concrete or other adequate covering.

Construction Joint. Joints not indicated on the plan shall be made and located as to least impair the strength of the structure. Where a joint is to be made, the surface of the concrete shall be thoroughly cleaned and all laitance removed. In addition to the foregoing, vertical joints shall be thoroughly wetted and slushed with a coat of neat cement grout immediately before the placing of new concrete.

Border Strip Insulation. Contractor shall furnish and install a 1-in. thick continuous asphalt-coated fiberboard insulating strip between exterior wall and floor slab as shown on plans. The depth of insulating strip shall be the same as the depth of the floor slab.

NOTE: The architect should specify and detail on plans the type of floor finish desired and specify the concrete surface finish required. Colored concrete, terrazzo, tile, linoleum, rubber, asphalt, carpet and hardwood floor surfacing materials are all adaptable to this type of concrete floor construction. See Portland Cement Association publication, *Suggested Specifications for Applying Finishes and Coverings on Concrete Residence Floors*, sent free on request in United States and Canada.

The activities of the Portland Cement Association, a national organization, are limited to scientific research, the development of new or improved products and methods, technical service, promotion and educational effort (including safety work), and are primarily designed to improve and extend the uses of portland cement and concrete. The manifold program of the Association and its varied services to cement users are made possible by the financial support of over 60 member companies in the United States and Canada, engaged in the manufacture and sale of a very large proportion of all portland cement used in these two countries. A current list of member companies will be furnished on request.

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